

CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

Sunnyside Cogeneration Associates
Sunnyside Cogeneration Facility
ACT/007/035, Carbon County, Utah

February 1993

Prepared By:

Utah Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah

Table of Contents

I.	Introduction	1
II.	Cumulative Impact Area (CIA)	3
III.	Scope of Mining.	3
	A. Sunnyside Mines.	3
	B. Sunnyside Cogeneration Facility.	5
IV.	Study Area	6
	A. Geology.	6
	B. Topography and Precipitation	7
V.	Hydrologic Resources	8
	A. Ground Water	8
	B. Surface Water.	10
	1. Right and Left Fork Grassy Trail Creek	10
	2. Whitmore Canyon.	10
	3. Price River-Lower Basin Grassy Trail Creek	12
	4. Iceland Creek.	12
	5. Price River-Lower Basin Horse Canyon	13
	C. Alluvial Valley Floors	13
VI.	Potential Hydrologic Impacts	14
	A. Ground Water	14
	1. Sunnyside Mining Company	14
	a. Dewatering	14
	b. Subsidence	18
	2. Sunnyside Cogeneration Associates.	18
	B. Surface Water.	19
	1. Sunnyside Coal Company	19
	a. Grassy Trail Creek	19
	b. Price River-Lower Basin Grassy Trail Creek	20
	2. Sunnyside Cogeneration Associates.	20
	a. Iceland Drainage	20
	C. Alluvial Valley Floors	21
	1. Sunnyside Coal Company	21
	2. Sunnyside Cogeneration Associates.	22
VII.	Summary.	22
	A. First Five Year Permit Term.	22
	1. Sunnyside Coal Company	22
	2. Sunnyside Cogeneration Associates.	23
	B. Future Mining.	23
	1. Sunnyside Coal Company	23
	2. Sunnyside Cogeneration Associates.	24
	References.	25

List of Figures

Figure 1:	Book Cliffs Coal Field.	2
Figure 2:	Cumulative Hydrologic Impact Area Map	4
Figure 3:	Book Cliffs Stratigraphy.	6
Figure 4:	Springs within CHIA Map	9
Figure 5:	Surface Water Drainages	11
Figure 6:	Precipitation isopachs.	15
Figure 7:	Long term impacts to ground water regime.	17

I. Introduction

This Cumulative Hydrologic Impact Analysis (CHIA) has been prepared for the Sunnyside Cogeneration Associates facility being permitted and constructed near Sunnyside, Utah. This document includes information which was previously prepared and used in the CHIA for the Sunnyside Mines which are located within this Cumulative Impact Area (CIA). This report references the Sunnyside Mine CIA and includes much of that information as prepared for the 1985 Sunnyside Mine permit. Additional information specific to the Sunnyside Cogeneration Facility has been prepared and included within this document. It is not the intent of this CHIA to re-address the Sunnyside Mine CHIA.

The purpose of this report is to provide a Cumulative Hydrologic Impact Assessment (CHIA) for the Sunnyside Cogeneration Associates facility (SCA) located in Carbon County, Utah. The CHIA encompasses the probable cumulative impacts of all anticipated coal mining in the general area on the hydrologic balance and whether the operations proposed under the SCA application have been designed to prevent damage to the hydrologic balance outside the proposed mine plan area. This report complies with federal legislation passed under the Surface Mining Control and Reclamation Act (SMCRA) and subsequent Utah and federal regulatory programs under UMC 786.19(c) and 30 CFR 784.14(f), respectively.

The SCA facility is located adjacent to the Book Cliffs Coal Field approximately 25 miles east of Price, Utah (Figure 1). The Book Cliffs form a rugged, southerly facing escarpment that delineates the Uinta Basin to the north from the San Rafael Swell to the south. Elevations along the Book Cliffs range from approximately 5,000 to 9,000 feet. The Sunnyside Cogeneration facility is located an elevation of approximately 6,500 feet.

Rocks of the Book Cliffs range from Upper Cretaceous to Quaternary in age. The rock record reflects an overall regressive sequence from marine (Mancos Shale) through littoral and lagoonal (Blackhawk Formation) to fluvial (Castlegate Sandstone, Price River Formation and North Horn Formation) and lacustrine (Flagstaff Formation and Green River Formation) depositional environments. Oscillating depositional environments within the overall regressive trend are represented by members of the Blackhawk Formation and the Colton Formation. The major coal-bearing unit within the Book Cliffs Coal Field is the Blackhawk Formation.

Annual precipitation varies from 20 inches at higher elevations to 5 inches at lower elevations. The Book Cliffs area may be classified as mid-latitude steppe to desert.

Vegetation varies from the sagebrush/grass community type at lower elevations to the Douglas fir/aspen community at higher elevations. Other vegetative communities include mountain brush, pinyon-juniper, pinyon-juniper/sagebrush and riparian. These communities are primarily used for wildlife habitat and livestock grazing.

Surface runoff from the Book Cliffs area flows into the Price River drainage basin of east-central Utah. The Price River originates near Scofield Reservoir and flows southeasterly into the Green River, north of Green River, Utah. Water quality is good in the mountainous headwater tributaries, but deteriorates rapidly as flow traverses the Mancos Shale. The shale lithology typically has low permeability, is easily eroded and contains large quantities of soluble salts that are a major contributor to poor water quality. Depending upon the duration of contact, water quality degrades downstream where total dissolved solids (TDS) levels of 3,000 milligrams per liter (mg/l) are not uncommon.

II. Cumulative Impact Area (CIA)

Figure 2 delineates the CIA for current and projected Sunnyside Mine operations, the SCA facility, and any reclaimed or proposed mining operations. The CIA is defined by surface drainages and the ground-water basin which corresponds to the surface topography. The CIA includes the Whitmore Canyon drainage basin, intermittent drainages south of the divide separating Rock Canyon and Bear Canyon and the upper drainage basin of the North Fork of Horse Canyon. The western boundary is designated by 110° 30' W longitude, whereas the southern boundary is limited by the Sunnyside Cogeneration's property line and its westward extension to 110° 30' W longitude. The CIA encompasses approximately 64,000 acres. Other potential mining external to the CIA include the proposed Sage Point-Dugout Canyon Mine to the west and the reclaimed Horse Canyon Mine located to the east. Impacts associated with mining external to the CIA occur in separate surface and subsurface drainage basins and, therefore, do not apply to this assessment.

III. Scope of Mining

A. Sunnyside Mines

Mining at Sunnyside, Utah began during the late 1890's. Total coal production has exceeded 55 million tons. Kaiser Steel Corporation acquired the Sunnyside properties in 1950 and operated the mines until April 1985. Since that time, the mine has been operated by Kaiser Coal Corporation and more recently by Sunnyside Coal Company.

Figure 1: Book Cliffs Coal Field
(From Doelling 1972)



EXPLANATION

PRIMARY ROADS

SECONDARY ROADS

U.S. HIGHWAY

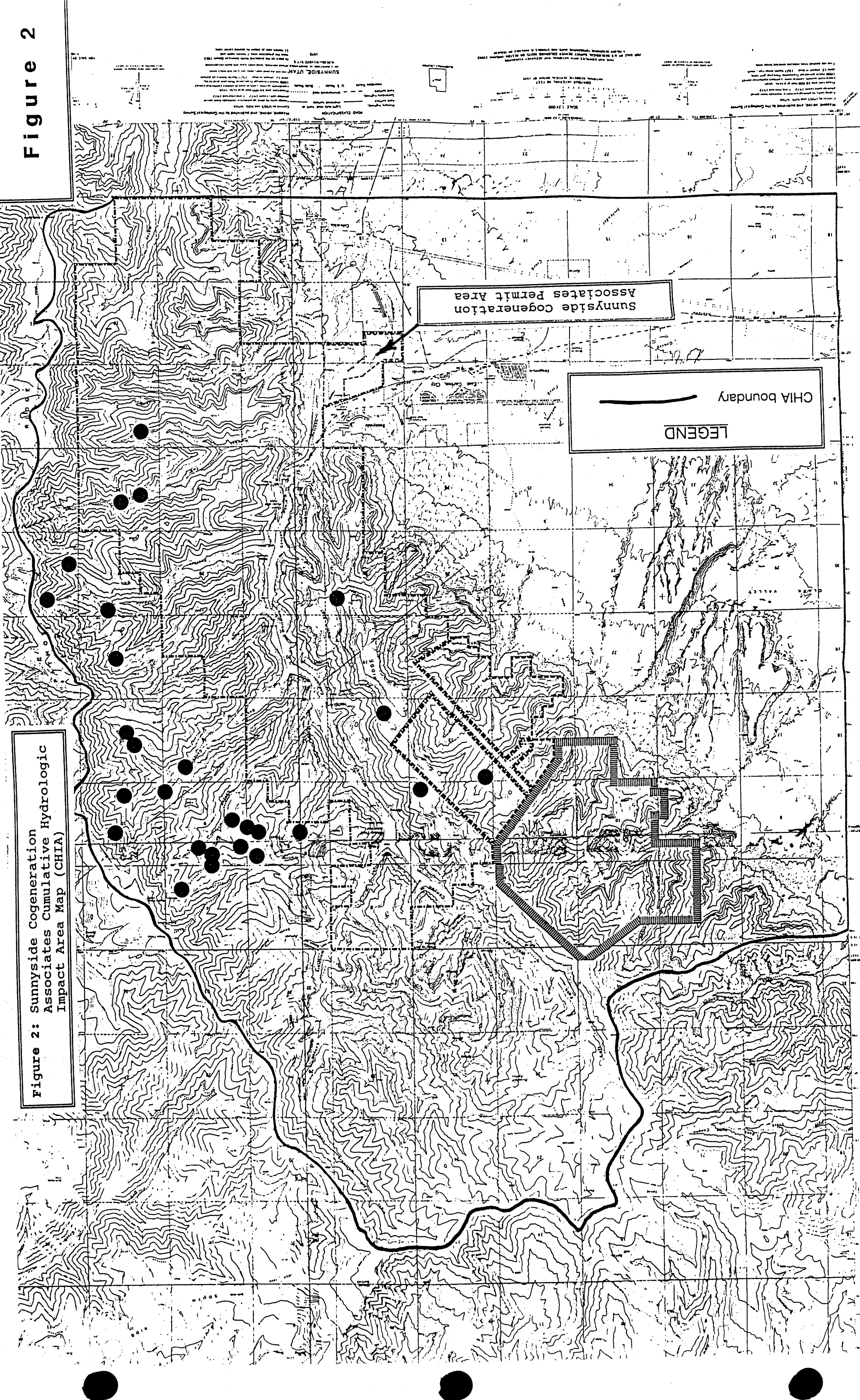
UTAH STATE HIGHWAY

50

10



Figure 2



These vegetation types are intermixed with grassland vegetation at lower elevations.

Riparian vegetation is located in the moist areas of the narrow canyon floors and along Grassy Trail Creek. This vegetation type is dominated by willows and sagebrush with an overstory of narrowleaf cottonwood and box elder.

V. Hydrologic Resources

A. Ground Water

The ground-water regime within the CIA is dependent upon climatic and geologic parameters that establish systems of recharge, movement and discharge.

Snowmelt at higher elevations provides most of the ground-water recharge, particularly where permeable lithologies such as fractured or solution limestone are exposed at the surface. Vertical migration of ground-water occurs through permeable rock units and/or along zones of faulting and fracturing. Lateral migration initiates when ground-water encounters impermeable rock layers and continues until either the land surface is intersected (and spring discharge occurs) or other permeable lithologies or zones are encountered that allow further vertical flow.

The Kenilworth Member, Sunnyside Member and Upper Mudstone Member of the Blackhawk Formation, Castlegate Sandstone, Bluecastle Sandstone Member of the Price River Formation, undifferentiated North Horn/Flagstaff Formation, Colton Formation, Green River Formation, and Quaternary deposits are potential reservoirs or conduits for ground-water in the CIA. Reservoir lithologies are predominantly sandstone and limestone.

Sandstone reservoirs occur as channel and overbank, lenticular and tabular deposits, whereas limestone reservoirs have developed through solution processes and fracturing. Shale, siltstone and cemented sandstone beds act as aquacludes to impede ground-water movement. The Mancos Shale is a regional aquaclude that limit downward flow within the CIA. Localized aquacludes include the Aberdeen Member and Lower Mudstone Member of the Blackhawk Formation, Lower Unnamed Member of the Price River Formation and relatively thin impermeable lithologies occurring within overlying units.

Thirty-six springs or area of multiple springs occur within the CIA (Figure 4). Three springs are located within Sunnyside Mines permit area. The majority of springs occur above 8,000 feet and discharge from the Green River Formation. Two springs

Stratigraphic units in the CIA generally strike northwest and dip to the northeast at angles of 5 to 12 degrees. The predominant fault trend is northwest-southwest, roughly paralleling strike. Fault displacement is generally less than 100 feet.

Principal coal accumulations occur within the Blackhawk Formation. Five coal seams have been identified and are termed, in ascending order: the Kenilworth, Gilson, Rock Canyon, Lower Sunnyside and Upper Sunnyside beds. The Lower and Upper Sunnyside beds have the greatest economic potential and are the focus of current and future Sunnyside Coal Company extraction operations.

B. Topography and Precipitation

Topography ranges from less than 5,800 feet to over 10,000 feet in the western and eastern portions of the CIA, respectively.

The western portion of the CIA, from 110° 30' W longitude to the crest of the West Ridge and south of the drainage divide between Grassy Trail Creek and Icclander Creek above Horse Canyon is characterized by southeast draining ephemeral streams that originate above 8,500 feet and progressively traverse nonmarine and marine Cretaceous rocks and alluvial fan deposits. Precipitation in the western portion of the CIA varies from 20 to less than 8 inches. However, a realistic approximation for average annual precipitation is 10 inches per year. Slopes associated with alluvial fans are approximately three to four percent, whereas slopes along the Book Cliff's escarpment between 7,000 and 8,800 feet average 22 percent.

The eastern portion of the CIA is characterized by a north-south perennial stream system with northeast-southwest trending tributaries. Headwaters originate above 10,000 feet and progressively traverse Tertiary and Cretaceous age rocks. Precipitation is less variable than in the western portion of the CIA and the average annual value is 20 inches or more. Slopes associated with the north-south system of perennial streams are approximately three to four percent below 7,500 feet. Slopes for northeast-southwest trending tributaries are approximately 32 percent above 7,500 feet.

There is a strong north-south slope effect on vegetation because of the narrow canyons. North facing slopes are dominated by Douglas Fir or mountainbrush communities with south-facing slopes are typically dominated by pinyon-juniper and sagebrush.

<u>YEAR</u>	<u>FINE MATERIAL</u>	<u>COARSE MATERIAL</u>	<u>TOTAL FUEL</u>
1993	106,692	303,308	410,000
1994	110,812	299,188	410,000
1995	76,347	333,653	410,000
1996	69,255	340,745	410,000
1997	95,106	314,894	410,000
TOTALS	458,212	1,591,788	2,050,000

IV. Study Area

A. Geology

The CIA is characterized by cliffs, narrow canyons, and pediments. Stratigraphic units outcropping within the area include from oldest to youngest, the Mancos Shale, Blackhawk Formation, Castlegate Sandstone, Price River Formation, undifferentiated North Horn/Flagstaff Formation, Colton Formation, Green River Formation and Quaternary deposits. Lithologic descriptions and unit thicknesses are given in Figure 3 below.

SYSTEM	SERIES	STRATIGRAPHIC UNIT	THICKNESS (Feet)	DESCRIPTION
QUATERNARY	Holocene Pleistocene	QUATERNARY DEPOSITS	Variable	Surficial stream terrace and channel, alluvial fan, landslide, talus and moraine deposits
TERTIARY	Eocene	GREEN RIVER FORMATION	100	Greenish-gray and white claystone and shale, also contains fine grained and thin bedded sandstone. Shales often dark brown containing carbonaceous matter. Full thickness not exposed.
		COLTON FORMATION	250 - 1,000	Brown to red lenticular sandstone, shale, and siltstone
		UNDIFFERENTIATED NORTH HORN/FLAGSTAFF FORMATION	1,200 - 1,800	Flagstaff consists of blue-gray to reddish brown limestone. North Horn predominantly gray to gray-green calcareous and silty shale, tan to yellow-gray fine-grained sandstone and minor conglomerate.
	Paleocene			
UPPER CRETACEOUS	Maestrichtian	PRICE RIVER FORMATION Bluecastle Sandstone Member Lower Unnamed Member	500	Yellow-gray to white, medium-grained sandstone and shaley sandstone with gray to olive-green shale. Contains carbonaceous shale with minor coal.
	Companian	CASTLEGATE SANDSTONE	180	White to gray, fine- to medium-grained argillaceous massive resistant sandstone with subordinate shale.
		BLACKHAWK FORMATION Upper Mudstone Member Sunnyside Member Lower Mudstone Member Kenilworth Member Aberdeen Member	700	Cyclical littoral and lagoonal deposits. Littoral deposits mainly thick-bedded to massive cliff forming yellow-gray fine- to medium-grained sandstone, individual beds separated by gray shale. Lagoonal facies consist of thin- to thick-bedded yellow-gray sandstones, shaley sandstones, shale and coal. Coal beds form basis of Book Cliffs Coal Field.
		MANCOS SHALE	4,000	Gray marine shale, locally heavily charged with carbonaceous material, slightly calcareous and gypsiferous, nonresistant forming flat desert surface and rounded hills and badlands.
	Santonian			
	Coniacian			

Figure 3: Stratigraphy of the Sunnyside, Utah Area (Modified from Doelling 1972 and Osterwald 1981).

Sunnyside Coal Company's Sunnyside operations include, from south to the north, the No. 2 Mine, No. 3 Mine and No. 1 Mine. The three mines are adjacent to each other and workings currently encompass the southern three-quarters of the permit area. Future mining is projected to occur towards the northwest and will include separate permits for the B Canyon and C Canyon areas.

Mine workings are approximately 6.5 miles in length and extend a maximum of 2.5 miles down-dip to the east. The first five year permit area encompasses 14,300 acres. Mining, during the first five year permit term, will occur in the Upper Sunnyside coal seam in the No. 3 Mine and Lower Sunnyside coal seam in the No. 1 Mine and No. 2 Mine. Sixty-five to eighty percent of the coal will be produced by longwall mining methods. The remaining production will be from continuous miner entry development and pillaring in areas unsuitable for longwall methods.

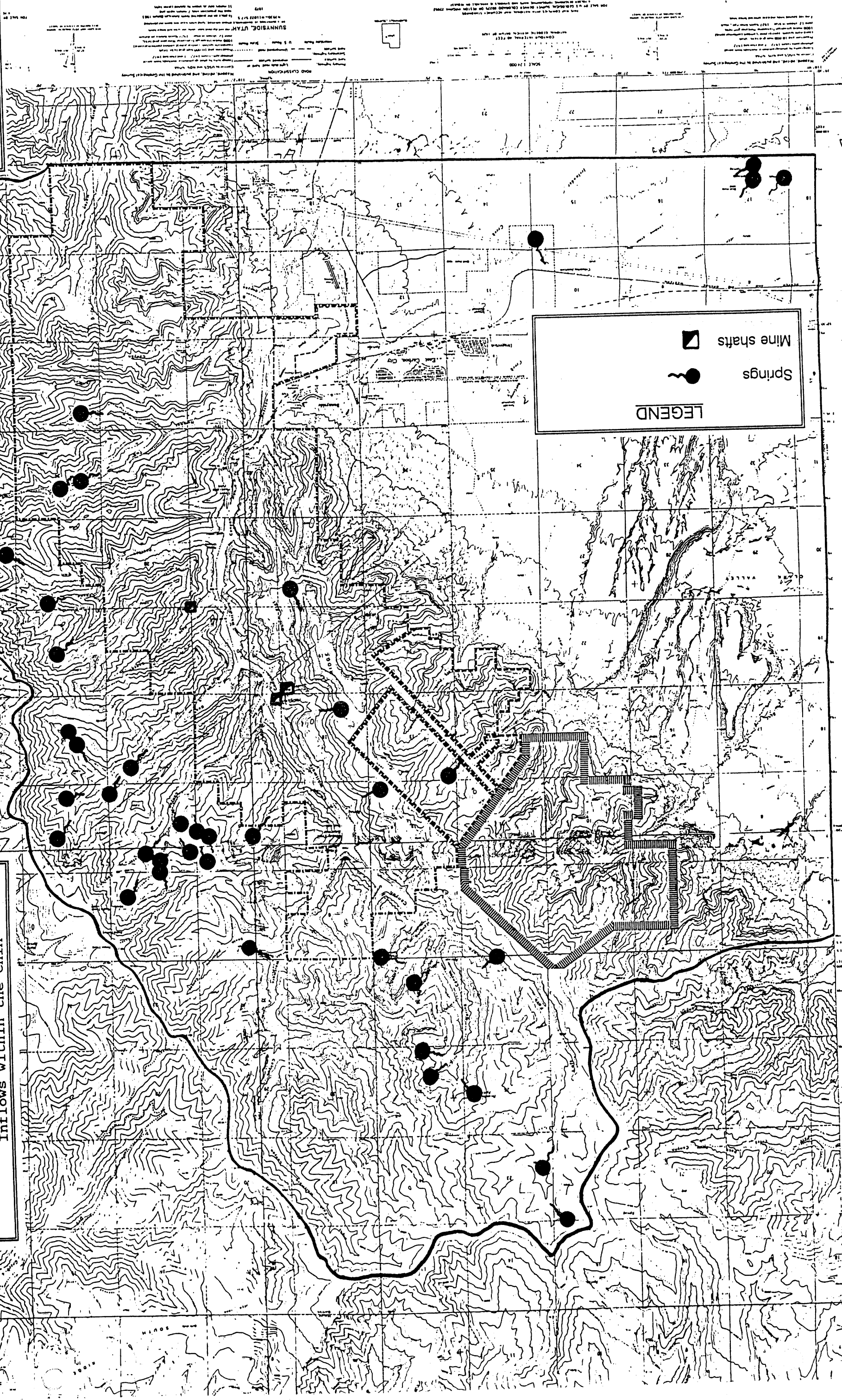
B. Sunnyside Cogeneration Facility

Sunnyside Coal Company's coarse refuse disposal area and slurry impoundments were acquired in 1988 by Sunnyside Cogeneration Associates (Environmental Power Corporation) to serve as a long term supply of fuel (coal mine waste-coarse refuse and slurry) to a cogeneration energy facility which was constructed adjacent to the refuse disposal area. Although the coarse refuse disposal area and slurry impoundments were acquired (property owners) SCA's alternative energy project was approved by the Federal Energy Regulatory Commission as a "Qualifying Facility" based on the use of coal mine waste as fuel in it's fluidize-bed combustion reactor.

SCA will utilize both active waste from the Sunnyside Coal Company processing plant and accumulated waste from the slurry impoundments and coarse refuse pile as fuel for it's facility. SCA's fueling plan will require excavating the slurry fines and the coarse refuse, blending and then burning this material in the power plant. Initial startup is scheduled for February 1993 and is proposed to continue for twenty years.

Production will consist of blending coarse material and fine material from abandoned and active slurry cells. Production in tons for the first five year permit term is projected listed below.

Figure 4: Location of Springs and Mine Shafts with Significant Inflows within the CHIA



occur in the southwest portion of the CIA and are associated with Quaternary alluvium overlying the Mancos Shale. These are within or adjacent to SCA's permit area. (Figure 5) Average flow is estimated to be less than 10 gpm for each spring.

Total mine inflow at the Sunnyside Mines is approximately 740 gpm from mine shafts (245 gpm), boreholes (300 gpm), paleochannels (10 gpm) and gobs, faults and fractures (185 gpm). The majority of inflow occurs in the No. 1 Mine and is associated with the Manshaft, Twin Shafts, Pole Canyon Shaft and 18th Left Outside Panel (Figure 4). The Manshaft and Twin Shafts penetrate from the Blackhawk Formation to undifferentiated North Horn/Flagstaff Formation and extend through the Castlegate Sandstone and Price River Formation. Flow into the Manshaft and Twin Shafts totals 160 gpm and is, most likely, derived from either the Bluecastle Sandstone Member and/or permeable lithologies in the undifferentiated North Horn/Flagstaff Formation. The Pole Canyon Shaft penetrates the Blackhawk Formation, Castlegate Sandstone, Price River Formation and Colton Formation. Pole Canyon Shaft inflow exceeds 50 gpm and is probably derived from the Colton Formation. The 18th Left Outside Panel collects flow from previously mined areas up dip. This flow may be attributed to wall weeps, roof drips and fractures and presumably represents aquifer dewatering within and adjacent to the coal seam (i.e., Kenilworth Member, Sunnyside Member, Upper Mudstone Member).

B. Surface Water

Four principal drainages occur within the CIA. These drainages are termed Grassy Trail Creek, Price River-Lower Basin Grassy Trail Creek, Icclander Creek and Price River-Lower Basin Horse Canyon (Figure 5). Grassy Trail Creek drainage has been further subdivided into Right and Left Fork Grassy Trail Creek and Whitmore Canyon/Grassy Trail Creek.

1. Right and Left Fork Grassy Trail Creek

Right and Left Fork Grassy Trail Creek are characterized by steep gradients, narrow canyons and gravel streambeds with silt and sand where gradients are reduced. Base flow is sustained by springs at approximately 8,500 feet.

Mining will be confined to areas beneath and adjacent to West Ridge. A subsidence barrier has been established to protect Grassy Trail Reservoirs and Right and Left Fork Grassy Trail Creek. Excepting the reservoirs, surface disturbance is limited to preexisting Class III access roads located along the Right Fork and Left Fork of Whitmore Canyon.

Figure 5: Surface Water Drainages
Within the CHIA

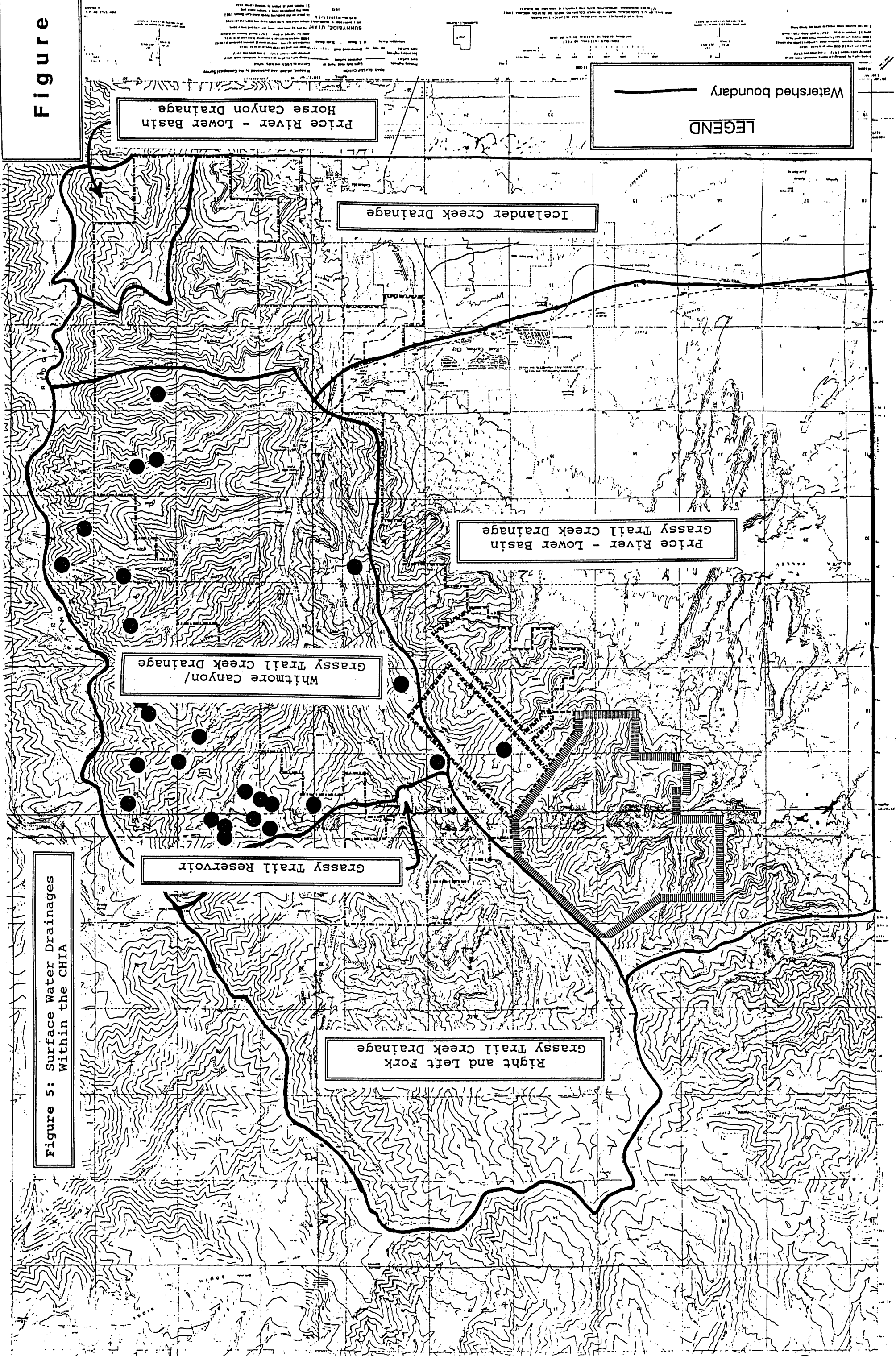


Figure 5

2. Whitmore Canyon

Grassy Trail Creek, from the permit boundary to the reservoir, is characterized by a low gradient (three to four percent), a relatively broad canyon (30 to 100 yards wide) and a bedrock streambed that is sporadically overlain by boulders, gravel, sand and mud. Grassy Trail Reservoir impounds upper Grassy Trail Creek flow and thus, has reduced the flooding potential associated with thunderstorm events. Flow records since 1979 for the Grassy Trail Creek below the reservoir have ranged from 10 cfs to 100 cfs.

Slaughter Canyon, Number Two Canyon, Pasture Canyon, Pole Canyon, Bear Canyon, and Water Canyon are tributaries to Grassy Trail Creek. These secondary drainages are characterized by steep gradients (greater than 25 percent), narrow canyons and gravel streambeds with sand and silt where gradients are reduced. Tributary flow is intermittent and in response to precipitation events.

Mining has occurred beneath most of Grassy Trail Creek and portions of the six tributaries. During the first five year permit term mining will extend northeast to encompass additional areas beneath Grassy Trail Creek, Number Two Canyon (Left Fork), Bear Canyon, and Water Canyon. Future mine development will continue to the north and northeast and progressively encompass additional areas beneath Grassy Trail Creek and the five tributaries entering from the east.

Most of the mining related surface disturbance is located along Grassy Trail Creek and includes the office and shop complex, loadout and preparation plant facilities, shafts, power substations and a variety of access and haul roads.

3. Price River-Lower Basin Grassy Trail Creek

The area west of West Ridge is characterized by low gradient (3 to 4 percent), ephemeral drainages with headwaters in short, steep gradient (greater than 20 percent) canyons.

Mining has occurred beneath West Ridge from Slaughter Canyon to Right Fork A Canyon and will encompass additional areas beneath West Ridge as mining extends towards the north into the B Canyon and C Canyon permit areas.

Surface disturbance is limited to ventilation portals in Fan Canyon and B Canyon and Class III access roads. Future disturbance will include a two tiered pad for coal loadout in C Canyon and a Class I haul road from C Canyon to State Highway 123. The haul road and highway will intersect approximately four miles west of East Carbon City.

4. Icelander Creek

Icelander Creek originates in Water Canyon and Fan Canyon south of the mine complex and is characterized by low (3 to 4 percent) to moderate (10 percent) gradients that traverse alluvial fan deposits and outcropping Mancos Shale. Springs associated with alluvial fan deposits and the seep[from the Coarse Refuse Area contribute flow to Icelander Creek. Approximately four miles below the Coarse Refuse Area, stream flow infiltrates into underlying sediments and Icelander Creek becomes dry.

Mining has occurred beneath Water Canyon and Fan Canyon and will occur beneath the upper portion of Water Canyon. Surface disturbance is confined to the Coarse Refuse Area, ventilation portals in Water Canyon and Fan Canyon and Class III access roads.

As the Coarse Refuse pile and the slurry pond fines are consumed, the Sunnyside Cogeneration project will over time diminish the flow at the base of the coarse refuse pile. As the cogeneration plant excavates and removes the coarse refuse material, the source of the seep will be uncovered and the source of the seep will be eliminated as the east and west slurry ponds are removed. This flow should cease during the life of the project if the project proceeds as planned.

5. Price River-Lower Basin Horse Canyon

A limited portion of the Horse Canyon drainage occurs within the CIA (Figure 5 above). The area is characterized by relatively steep gradients and intermittent flow.

Mining has occurred beneath most of the area and will occur in a small portion of the No. 2 Mine (12th Right Panel) during the first five year permit term. Surface disturbance related to mining in this CIA has not occurred and will not occur in the Horse Canyon drainage area.

C. Alluvial Valley Floors

Grassy Trail Creek, from the mouth of Straight Canyon to 110° W longitude, has been determined to be an Alluvial Valley Floor (AVF). The positive determination was based on the presence of unconsolidated streamlaid deposits holding streams and sufficient water to support agricultural activities as evidenced by the existence of flood (and sprinkler) irrigation or its historical use. Approximately 1,100 acres either are or have been irrigated.

The designated AVF is adjacent to the permit area and located within the dissected portions of alluvial fan deposits that characterize the eastern portion of the CIA.

The majority of Sunnyside Mine discharge (740 gpm) is directed to Grassy Trail Creek and irrigation systems located along the creek. Over half of the acreage reported in alfalfa is irrigated with mine water.

VI. Potential Hydrologic Impacts

A. Ground Water

Dewatering and subsidence related to mining have the greatest potential for impacting ground-water resources in the CIA. The SCA project should have minimal to no impact on the groundwater resources.

1. Sunnyside Coal Company

a. Dewatering

The volume of water being discharged from the No. 3 Mine and No. 1 Mine (740 gpm) approximates the amount of water that is currently being withdrawn from the ground-water system. The withdrawal value may be compared to an estimated value for recharge within the CIA and thereby, allow an assessment of dewatering impacts.

Approximately 33,000 acres of the total area within the CIA are above 7,500 feet where average annual precipitation is approximately 20 inches (Figure 6). Topography above 7,500 feet is less steep than the canyon areas below and outcropping rocks include the relatively permeable lithologies within the undifferentiated North Horn/Flagstaff Formation, Colton Formation, Green River Formation, and Quaternary deposits.

Recharge has been estimated to be 3 to 8 percent (Danielson and Sylla, 1983), 9 percent (Waddell et al, 1983) and 12 percent (Simons, Li & Associates, 1984) of the average annual precipitation for areas in the Wasatch Plateau and Book Cliffs coal fields. The recharge rate for areas above 7,500 feet may be derived as shown below:

$$\frac{(\% \text{ recharge}) \times (\text{average annual precipitation}) \times (\text{area})}{\text{time}} = \text{Recharge Rate}$$

Calculations using estimated recharge values of 4, 8 and 12 percent of the average annual precipitation above 7,500 feet give recharge rates of 1,360 gpm, 2,720 gpm and 4,080 gpm,

Figure 6: Areas of Relatively Greater Recharge within the CHIA

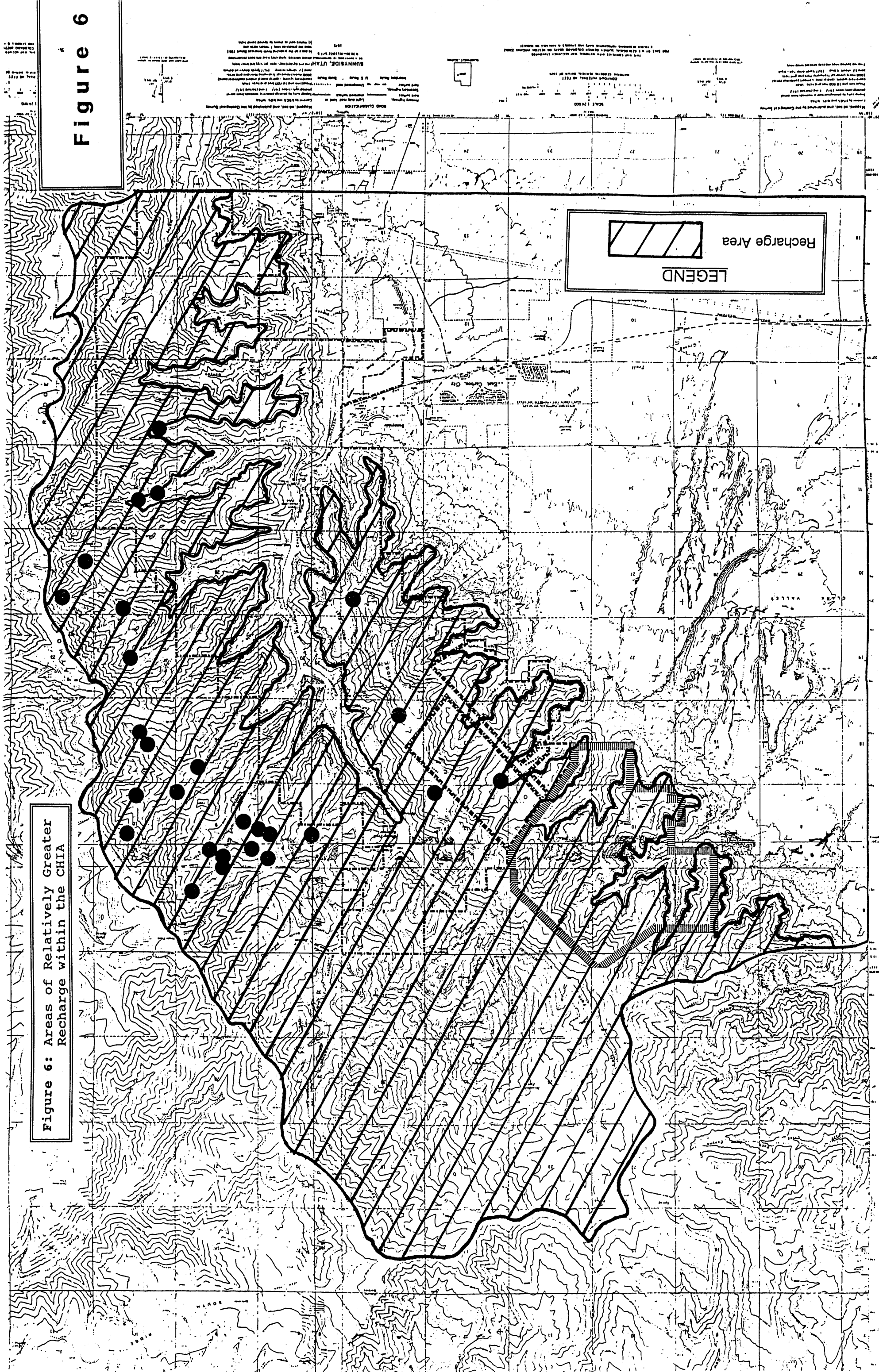


Figure 6

respectively. A comparison of the rate of current mine discharge (740 gpm) to the range of calculated rates of recharge (1,360-4,080 gpm) indicates approximately 20 to 50 percent of the recharge is currently being intercepted by mine operations. If the rate of mine discharge is less than the rate of recharge, then the water being accessed by mine operations constitutes flow through the system rather than depletion of ground-water storage within the system. Hence, the current dewatering associated with Sunnyside operations is considered to not significantly impact piezometric surfaces within the CIA.

Mining during the first five-year permit term will encompass approximately 385 acres. It is not anticipated that the rate of discharge will exceed the recharge rate during this permit term. However, as mine operations expand in the future to encompass the proposed B Canyon (1,910 acres) and C Canyon (2,650 acres) permit areas and additional areas in the No. 1 Mine, No. 2 Mine and No. 3 Mine (1,450 acres), an increase in discharge is anticipated. At present, data is not available to precisely document increases in mine discharge. An estimate of discharge increase may be derived by multiplying the discharge per acre of present mine workings times the projected area of mine workings as shown below:

$$\frac{\text{present discharge rate}}{\text{present area of workings}} \times \text{projected area of workings} = \text{estimated discharge increase}$$

The above calculation indicates discharge will approach the value for recharge as the mine workings encompass an additional 4,000 acres in approximately 20-30 years. As discharge increases and surpasses values for recharge, certain spring flow and base flow recharge to streams may gradually decrease until ground-water storage begins to be depleted. Conceivably, depletion may continue (at increasing rates) until spring flow and/or base flow recharge to streams ceases. Figure 7 depicts potential long-term mining impacts to the ground-water regime.

Upon termination of mining operations, ground-water discharge to Grassy Trail Creek will be discontinued and the mine will begin to flood. The potential reduction in surface flow that is associated with the cessation of operations may be evaluated in terms of the lag time required for reestablishment of base flow recharge.

The impact associated with the reduction in surface flow is considered temporary. Mine flooding will conceivably reestablish a system of base flow recharge that was operational prior to mining. The time span required for reestablishing base flow

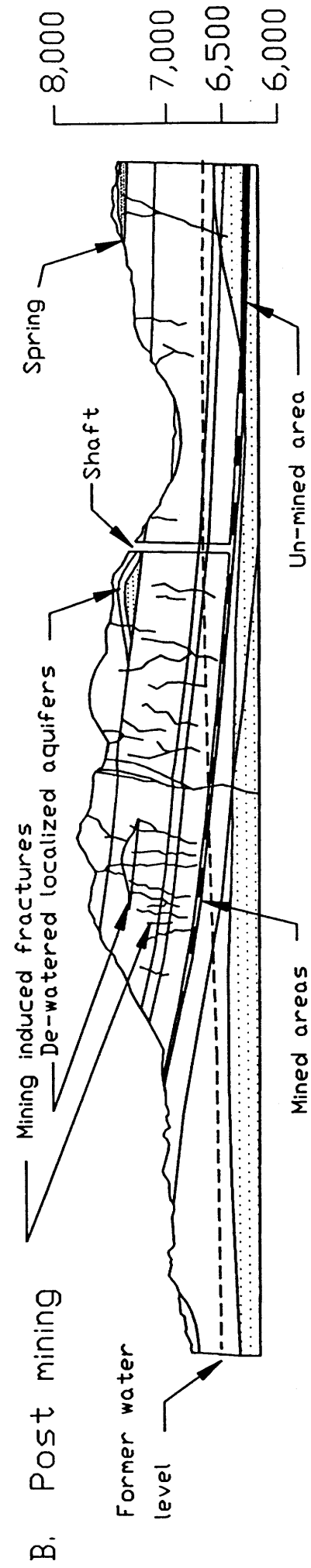
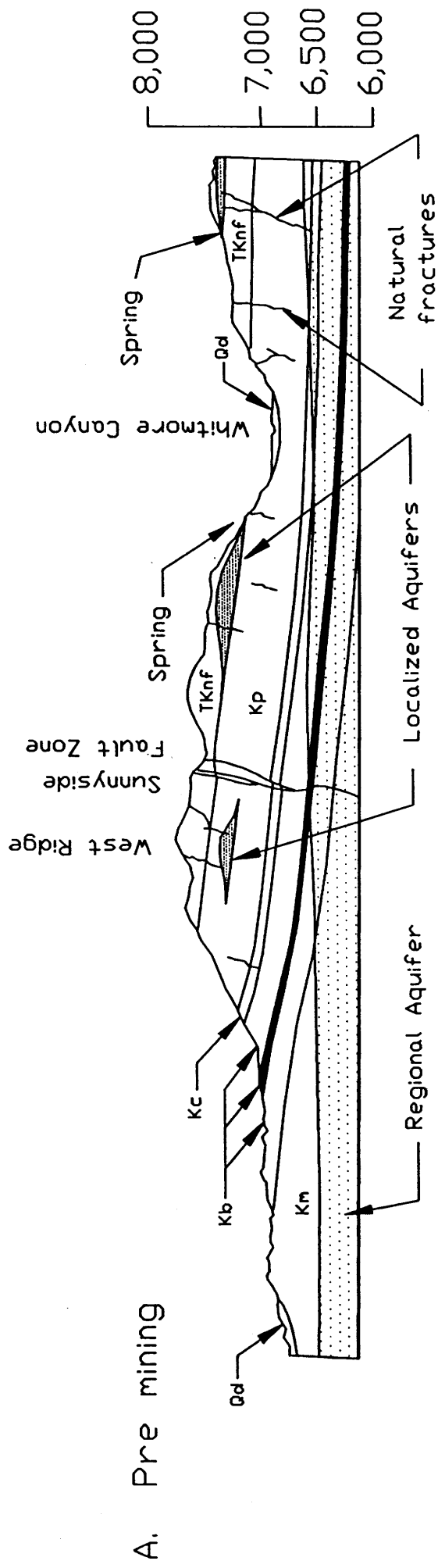


Figure 7: Long Term Impact to Groundwater Regime

recharge may be estimated by dividing the final mine workings volume by the final estimated values for mine discharge.

$$\frac{\text{final volume of mine workings}}{\text{final rate of mine discharge}} = \text{flooding time}$$

The maximum lag time for mine flooding may be derived by assuming the workings will remain open (average five foot height) and caving will not occur. Accordingly, for the Sunnyside Mines, the computation provides an upper limit of 26 years for complete mine flooding. It should be noted that complete flooding will, undoubtedly, never be achieved because the hydraulic head generated as flooding expands will also increase until the hydraulic properties of the roof, floor and rib are exceeded and flow through the rocks is initiated.

The proposed ground-water monitoring program for the Sunnyside Mines will, in the future, allow increasing discharge rates to be more precisely characterized and thereby, achieve a more accurate assessment of mining related dewatering impacts.

b. Subsidence

Subsidence impacts are largely related to extension and expansion of the existing fracture system and upward propagation of new fractures. Inasmuch as vertical and lateral migration of water appears to be partially controlled by fracture conduits, readjustment or realignment in the conduit system will inevitably produce changes in the configuration of ground-water flow. Potential changes include increased flow rates along fractures that have "opened" and diverting flow along new fractures or within permeable lithologies. Subsurface flow diversion may cause the depletion of water in certain localized aquifers and potential loss of flow to springs that will be undermined (three total). Increased flow rates along fractures would reduce ground-water residence time and potentially improve water quality.

A maximum value of 1.5 feet of surface subsidence has been recorded over the 18th Left Inside Panel, No. 1 Mine (6,000 feet x 600 feet) beneath approximately 1,000 feet of overburden. The presence of the Castlegate Sandstone in conjunction with overburden thickness (approximately 1,000 feet) is apparently responsible for reduced surface subsidence. Additional mining during the five-year permit term will occur beneath 1,500-2,000 feet of overburden. Consequently, the potential for subsidence related surface impacts (e.g., ponding) to the subsurface and surface hydrologic regimes are not considered significant.

2. Sunnyside Cogeneration Associates

The Sunnyside Cogeneration Associates' project is situated in an area where the refuse from the Sunnyside Mines has been disposed of for years. The refuse material has been placed in a natural drainage similar to a head of hollow fill. The seep at the toe of the refuse pile is believed to be caused from water infiltrating down through the slurry cells. This water then flows along the contour of the natural drainage channel emerging at the toe of the refuse pile. Samples of this seep have indicated that acidic conditions do exist within the refuse pile. Additionally, the temperature of the seep indicates that this water is being heated by the buried coal fires located within the refuse pile. Certain metals (i.e. inert manganese) are elevated well above the average concentrations of that found in adjacent natural springs. This may indicate oxidation of pyrite within the refuse, a subsequent decrease in pH and the dissolution and transport of metals.

The applicant has committed to sampling this seep at the source and analyzing for the baseline parameters found in the Division's Guidelines for Establishment of Surface and Groundwater Monitoring Programs for Coal Mining and Reclamation Operations. This monitoring will provide additional data as to the toxicity of this seep. Throughout the life of this operation the excavation and removal of coarse refuse material and the fines from the slurry cells will slowly diminish and remove the source of this seep.

B. Surface Water

1. Sunnyside Coal Company

a. Grassy Trail Creek

The concentration of total dissolved solids (TDS) increase from 250-451 mg/l above to 1,250-2,000 mg/l below the Sunnyside Mines (Waddell, 1981). The TDS value for mine water discharge is 1,600 mg/l. Moreover, above the mines, calcium, magnesium and bicarbonate are the predominant ions and below the mines sodium, bicarbonate and sulfate are dominant (Waddell, 1981). These increases are attributed to the addition of mine water discharge which is similar to ground-water that has been mineralized through contact with the Mancos Shale.

The mine water from the Sunnyside Mines supplies 1,473 tons of dissolved solids per year to Grassy Trail Creek based on an average mine water discharge for the years 1978-1984. The Price River at Woodside carries 291,620 tons of dissolved solids per year based on an average discharge per year (USGS Water Data Reports 1979-83). It is important to mention that the water in Grassy Trail Creek is used for irrigation and based on this assumption, the salt entering the Price River from mine water is

less than the 1,473 tons given above due to loss of water for irrigation in the Sunnyside area. Infiltration and evaporation from irrigation also influences the amount of water and ultimately salt content eventually discharging to the Price River.

The average concentration of TDS in mg/l for mine water from the Sunnyside Mines is 1,600 (Sunnyside MRP). The water in Grassy Trail above the mine averages approximately 300-500 mg/l TDS. The average concentration of TDS for Grassy Trail Creek for the combination of mine water and creek water from above the mine varies from 300 mg/l to 1,800 mg/l depending on the flow and season (personal communication, Doug Pearce, Sunnyside Mine). The Utah Department of Health's standard for TDS for the Sunnyside Mines is 2,200 mg/l for industrial uses and 1,200 mg/l for agricultural uses. The mine water meets the industrial (Class 5) numerical standard for protection of the beneficial uses of water, but on occasion will exceed the agricultural standard.

It should be pointed out that without mine water, none or little irrigation water would be available to the downstream users. Even though the creek water is marginal quality for irrigation, the quantity makes irrigation feasible in the Sunnyside area. As well as providing irrigation water, Grassy Trail Creek supplemented by mine water supports a put-and-take fishery (Section 10.3.2.1, page 5, MRP).

Wingate (1981) identified the following impacts to Grassy Trail Creek. "(1) Grassy Trail Reservoirs has altered the stream's natural flow regime, (2) mine discharge waters have resulted in considerable changes in water quality of the lower stream section and (3) use of coarse refuse coal mine waste materials as road bed fill appears to contribute to aquatic resource deterioration."

Mine waste is presently directed to sediment ponds and then released to Grassy Trail Creek at NPDES discharge points #001 and #002. The treatment associated with these ponds improves suspended solids and oil and grease parameter values, but overall total dissolved solids (TDS) values remain in the range of 1,600 mg/l below the #002 discharge point. The #001 mine water pond was installed during the 1985 and the #002 mine water pond was installed during 1981. Future impacts from surface facilities and mine water discharge are not anticipated to increase from present levels. The quantity of mine water may increase, causing increased TDS levels downstream and suspended solid values will decrease as sediment controls are implemented in problem areas.

b. Price River-Lower Basin Grassy Trail Creek

Surface disturbance west of West Ridge will be confined to future C Canyon development. Sediment control measures for both the loadout facility and haul road will be implemented in association with the permit approval process to minimize hydrologic impacts.

2. Sunnyside Cogeneration Associates

a. Icelander Drainage

The coarse refuse disposal area, the #004 discharge point (includes discharge from the Clear Water Pond), Water Canyon and Fan Canyon all drain to the Icelander Creek.

Impacts in terms of surface water degradation have occurred at the #004 NPDES discharge point and Coarse Refuse Seep. The #004 discharge data indicate total suspended solids (TSS) values in the range of 1,400 ppm and oil and grease values in the range of less than 1 to 45 mg/l. The values for oil and grease since October of 1992 have been within acceptable limits, therefore, future impacts related to oil and grease contaminants are not anticipated.

Icelander Drainage is also affected by water from the Coarse Refuse Seep. The fires within the refuse pile and pyrite oxidation (exothermic reaction) cause a temperature of 28°C and a TDS value of approximately 5,000 mg/l at the Coarse Refuse Seep. Total iron has been recorded as high as 55.0 mg/l at the source.

Sunnyside Coal Company previously treated the seep with flocculants and has proposed to mitigate future impacts by (1) determining the source of the Coarse Refuse Seep and attempting to intercept the flow before it contacts the refuse material or (2) implementing a more effective means of treating the discharge. NOV #N92-32-14-1 was issued on November 11, 1992 for "Failure to comply with the terms and agreements of the approved mining and reclamation permit. Failure to treat the water emanating from the bottom of the wash below the coarse refuse pile (Sampling Point CRS) by the addition of flocculent to reduce the iron content." As of this writing, the Division of Water Quality, Department of Environmental Quality, has noted that a request for a permit modification (UT0022942) (regarding this issue) had been made by Sunnyside Coal Company but not resolved to date.

Sunnyside Cogeneration Associates will attempt through the use of dyes placed in the East Slurry Cell or other studies to track the flow of water from the East Slurry Cell to the Coarse Refuse Seep. If a connection is determined, then remedial action

will be taken, such as discontinuing the use of the East Slurry Cell. Flocculant had been added to the seep to precipitate Iron, but is not being added currently and according to DWQ shouldn't be treated in the stream.

The applicant has committed to monitor this seep at the point of emergence for baseline data. Sediment controls are currently in place, so any future impacts associated with suspended solids are not anticipated.

Water Canyon and Fan Canyon empty into the Icелander Drainage after they combine to form Water Canyon. Sunnyside Mining Company's #005 NPDES mine water discharge point is located in Water Canyon. The discharge pipe is currently buried under sediment in the stream channel and is not presently used. The last discharge from the #2 Mine was February 24, 1982. Water Canyon and Fan Canyon have sediment controls in place and only flow in response to major rainfall events. Mine water discharged from the #005 point does not reach Water Canyon due to infiltration along the stream bottom and the quantity of mine water discharge (Doug Pearce, personal communication, May 1985). Thus, future impacts are not anticipated.

C. Alluvial Valley Floors

1. Sunnyside Coal Company

The Utah Supreme Court review of Joseph R. Sharp vs. George C. Whitmore (Decree #3028) indicated the premining flow regime for Grassy Trail Creek was intermittent during most years. Since the addition of mine discharge and construction of Grassy Trail reservoir, flow has been exclusively perennial.

At present, mine discharge accounts for 23 percent of the average annual flow in Grassy Trail Creek. Accordingly, this proportion would decrease during spring runoff and increase during periods of low flow in the late summer and fall.

Agricultural activities associated with the designated AVF currently benefit from the additional surface flow generated by mining activities. It is anticipated that this relationship will continue until the cessation of mining. At that time, discharge pumping will be discontinued and surface flow will be reduced. As indicated earlier, mine flooding will begin and continue until flow through the rocks is initiated. Conceivably, a ground-water regime similar to that which existed prior to mining will eventually reestablish.

2. **Sunnyside Cogeneration Associates**

Although the coarse refuse pile and slurry ponds associated with the SCA permit area are located on the alluvial fan, they are more isolated from the Grassy Trail Creek alluvial valley floor. The refuse pile historically has been placed in several small drainage channels. As excavation and consumption continue throughout the life of the project, the existing natural channels will be uncovered and reclaimed.

VII. **Summary**

The probable hydrologic impacts are summarized below under the headings entitled First Five Year Permit Term and Future Mining.

A. **First Five Year Permit Term**

1. **Sunnyside Coal Company**

The rate of dewatering will remain significantly less than the estimated recharge rate during the first five year permit term. Moreover, overburden thickness will be sufficient (1,500-2,000 feet) to restrict surface manifestations of subsidence. The subsurface propagation of fractures may produce changes in ground-water flow that could affect localized aquifers and springs. Future monitoring will provide data applicable to documenting changes in the ground-water system.

Surface disturbance and the addition of mine water have degraded water quality in Grassy Trail Creek and Iceland Creek. Sediment control measures have served to reduce contaminants and stabilize water quality at acceptable levels.

The AVF will be positively impacted during the first five year permit term by additional flow from increased mine water discharge.

2. **Sunnyside Cogeneration Associates**

The first five year permit term will probably not see big improvements in the configuration of the refuse pile and slurry ponds in relation to the natural channels. The projected use of the coarse refuse and slurry pond fines combined is proposed at 410,000 tons per year. The first permit term proposes that approximately 1,591,788 tons of coarse refuse material and 458,212 tons of slurry pond fines will be excavated, removed and burned. This equals 22 percent of the total estimated quantity of material available in the refuse pile and slurry ponds.

B. Future Mining

1. Sunnyside Coal Company

Increased rates of dewatering may, in the future, result in depletion of ground-water storage. Depletion of storage may terminate certain spring flow and base flow recharge to streams. Upon cessation of mining, mine water discharge to Grassy Trail Creek will be discontinued. However, this affect is considered temporary because mine flooding will probably result in reestablishment of the preexisting ground-water system that, most likely, provided base flow recharge to Grassy Trail Creek.

Drainage from future surface disturbance will be managed through appropriate sediment controls. Future mine discharge will be directed through existing sediment ponds.

At the termination of mining, the AVF will experience decreased flow. The duration and extent of this impact cannot be accurately assessed at this time. However, flow rates may be partially to fully restored when the ground-water system is reestablished.

The operational design proposed for the Sunnyside Mines is herein determined to be consistent with preventing damage to the hydrologic balance outside the mine plan area.

2. Sunnyside Cogeneration Associates

Assuming that projected combustion rates provided in the application are accurate, then approximately 22 percent of the amount available will be consumed in the first permit term. This provides enough quantities of material to fuel the plant for 4.5 permit terms or 23 years. Considering that refuse from the active Sunnyside Mine will also be incorporated into this project and that it is anticipated that Sunnyside Mines will produce 264,000 tons per year (64 percent of amount consumed), then the existing combustible amounts plus that produced by the active Sunnyside Mines would increase the life of the operation by about 40 years.

Non-combustible waste from this operation will be disposed of in areas within the permit area. These areas will not include head of hollow fills. The final configuration and restoration of the natural drainages will be completed near the end of the project as the material is removed and areas are exposed.

The nature of the Sunnyside Cogeneration Facility is such that no underground mining will occur in the permit area. The only mining will consist of removal of the refuse and slurry materials. Sediment ponds exist within the permit area to control storm water runoff and reduce sediment loads offsite.

The consumption of the refuse pile and slurry ponds will over time eliminate the seep at the toe of the refuse pile. This should increase water quality in Iceland Creek by eliminating a potential source of water pollution. The operational design proposed for the Sunnyside Cogeneration facility is herein determined to be consistent with preventing damage to the hydrologic balance outside the permit area.

REFERENCES

Danielson, T. W., and Sylla, D. A. 1983. Hydrology of coal-resource areas in southern Wasatch Plateau, Central Utah: U. S. Geol. Surv., Water-Resource Investigations Report 82-4009.

Doelling, H. H. 1972. Central Utah coal fields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs and Emery: Utah Geol. and Mineral Surv., Monograph Ser. No. 3.

Kaiser Coal Corporation, Application for an Underground Coal Mine Permit, March 1, 1985, Sunnyside Mine, Sunnyside, Utah.

Lines, G., et al. 1984. Hydrology of area 56, Northern Great Plains and Rocky Mountain coal provinces, Utah: U. S. Geol. Surv., Water-Resources Investigation Open-File Report 83-38.

Osterwald, F. W., et al. 1981. Bedrock, surficial and economic geology of the Sunnyside coal mining district, Carbon and Emery Counties, Utah: Geol. Surv., Professional Paper 1166.

Simons, Li and Associates, Inc. 1984. Cumulative hydrologic impact assessment Huntington Creek basin, Emery County, Utah: Prepared for Office of Surface Mining, Project UT-OSM-06.

Waddell, K. M., et al. 1978. Selected hydrologic data, 1931-77, Wasatch Plateau-Book Cliffs coal fields area, Utah: Utah Basic Data Release No. 31, U. S. Geol. Surv., Open-File Report 788-121.

Waddell, K. M., et al. 1981. Hydrologic reconnaissance of the Wasatch Plateau-Book Cliffs coal field area, Utah: U. S. Geol. Surv., Water Supply Paper 2068.

Waddell, K. M., et al. 1982. Selected hydrologic data, Price River Basin, Utah, water years 1979 and 1980: U. S. Geol. Surv., Utah Hydrologic Data Report No. 38, Open-File Report 82-916.

Winget, R. N. 1980. Aquatic resource analysis of Grassy Trail Creek, Carbon County, Utah.